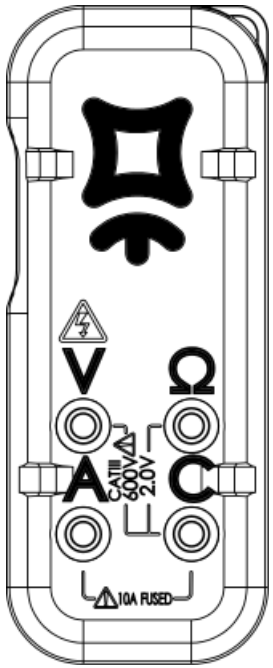
MOOSHIMETER USER'S MANUAL



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INTRODUCTION

The Mooshim Mooshimeter BLE-DMM-2X-01A (hereafter "The Meter") is a battery powered multimeter capable of handheld and remote usage via Bluetooth Low Energy. This manual details how to safely use your Mooshimeter.

The Meter meets CAT III IEC 61010-1 3rd edition and 61010-2-030 standards. Overvoltage category III (CAT III) defines a level of safety appropriate for the transient overvoltages present in fixed equipment installations at the distribution level. This includes the mains installation of a building, distribution boards, busbars, and permanently connected equipment. Do not use this multimeter for CAT IV circuits, which includes any mains circuits not protected by a building's breakers.

PACKAGE CONTENTS

- Mooshimeter (1)
  - 1.5V AA Alkaline Batteries installed (2)
  - 12A HRC fuse installed (1)
- Test Leads (3)
- Alligator Clip Attachment (3)
- Carrying case (1)

SAFETY INFORMATION

WARNING *Denotes a potentially hazardous situation that may result in injury or death*

CAUTION *Denotes a potentially hazardous situation that may result in damage to the meter*

NOTE *Denotes a situation that may result in degraded or incorrect measurement*

- Use caution in the operation of this device. Improper use may result in injury or death. Read this user manual before operating the meter.
- Always remove leads before opening the case.
- Do not operate the meter unless it is fully assembled with both case screws tight.
- Only use appropriately rated fuses.
- Always check for damage before use. Pay special attention to the test leads for signs of damaged insulation or exposed conductors. Immediately replace damaged leads.
- Only use test leads that are rated to at least CAT III 600V.
- Keep fingers behind the guards on the leads.
- Use caution working with voltages above 30VAC rms, 42VAC peak, or 60VDC. Voltages this high pose risk of shock.
- Never apply more than 600V between any terminal and earth ground.
- Do not apply more than 2.0V to the auxiliary terminal with respect to Common. Doing so may draw unexpected current and trigger protection circuits. In this event, basic functionality will automatically return within one minute. Accuracy may be adversely affected for up to five minutes.
- Error messages may appear on the user interface. Read these messages for further information.

TABLE 1 SYMBOLS

	Caution: Risk of Electric Shock. Refer to operating instructions.
	Important Information: Refer to operating instructions.
CAT III	This instrument is rated for installation category III per IEC 61010.
	Double Insulation
	Terminal protected by fuse. Current limit of 10A RMS.
	Conforms to European Union Directives
	Do not exceed 600V with respect to ground.

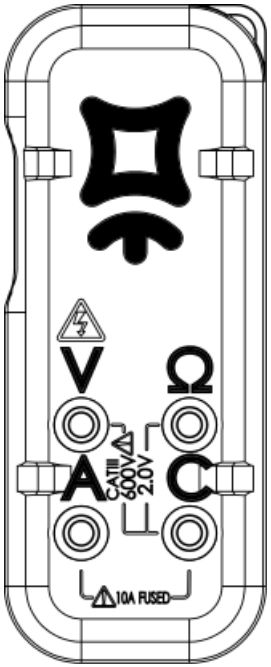


TABLE 2 TERMINALS

Terminal	Description
C	Common terminal for all measurements
V	Input terminal for measuring currents to 10A RMS (AC and DC)
A	Input terminal for measuring voltages to 600V RMS (AC and DC)
Ω	Input terminal for measuring resistance, diode drop, and voltages up to 1.2V

BASIC MEASUREMENT INSTRUCTIONS

MEASURING VOLTAGE

WARNING *Risk of Electrocution. For determining whether a circuit is "live" exercise caution if the meter does not report a voltage. This may indicate a poor connection to the circuit being tested. Make sure the probe tips are fully in contact with the circuit before assuming the circuit is safe.*

Two of the Mooshimeter's input terminals are capable of making basic voltage measurements:

The **V** terminal can measure up to 600V RMS and is intended for traditional AC and DC voltage measurements.

The **Ω** terminal can measure up to 1V peak (~0.7V RMS for pure-sine AC) and allows for several new measurement techniques described later in this manual.

See the ratings section for further details on the measurement ranges.

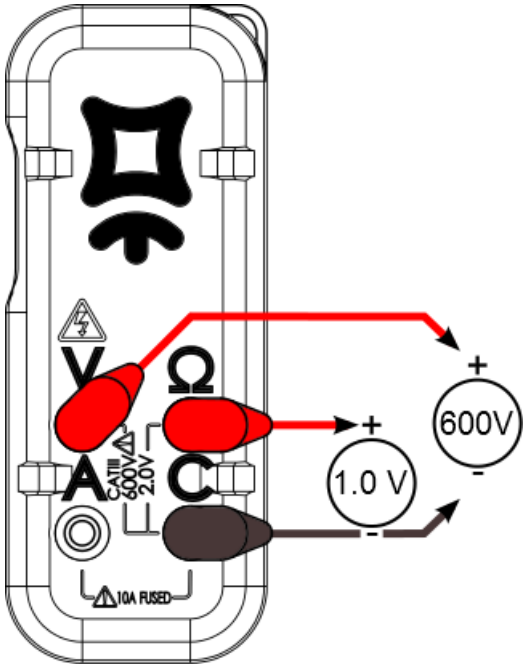


FIGURE 1 BASIC VOLTAGE MEASUREMENT

MEASURING CURRENT WITH INTERNAL CURRENT SHUNT

WARNING *Exercise care when connecting in series with a circuit, especially those containing motor(s). Sudden disconnects may create higher than expected voltages due to inductive kick.*

WARNING *Perform a Fuse Check before measuring currents with the internal current shunt. Exercise caution in determining whether a circuit is "live" if the meter does not report a current. This may indicate either a poor connection or a blown fuse.*

NOTE *AC current range is limited by the instantaneous current. Peaks above the listed limits will result in incorrect readings. Derate AC current limits with high crest factors accordingly.*

Disconnect power from the circuit to be measured.

Break the circuit and wire the meter in series through the "A" and "C" terminals.

Positive DC current flows into the "A" terminal.

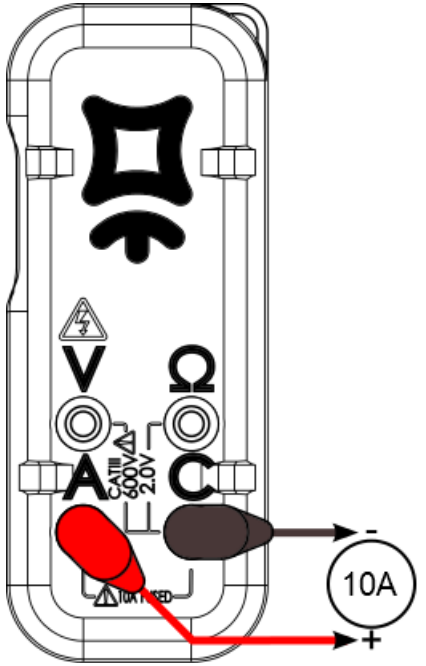


FIGURE 2 BASIC CURRENT MEASUREMENT

MEASURING CURRENT WITH AN EXTERNAL CURRENT SHUNT

WARNING *This measurement mode is capable of measuring currents many orders of magnitude larger than is typically possible with a handheld meter. Exercise caution while interfacing to high ampacity circuits.*

NOTE *The accuracy of this measurement mode depends on the accuracy of the external current shunt used. Account for this accuracy dependency in your measurements.*

The Ω terminal can measure small voltages, with a resolution of as fine as 25nV per count and a noise floor as low as 1µV. This can be used to with external current shunts to measure currents over a very wide dynamic range. See the ratings section to guide shunt size selection.

It is possible to use the existing wiring for the current shunt, and in doing so take rough current measurements without breaking the circuit.

With very low voltages it is recommended to minimize the loop area of the measurement probes by either twisting them together or using a BNC adaptor.

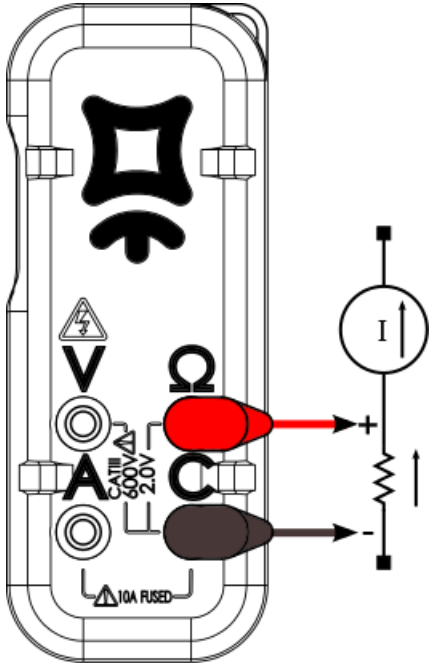


FIGURE 3 EXTERNAL CURRENT SHUNT

NOTE *Do not measure resistance on a live circuit. Doing so will result in incorrect readings and may engage the internal protection circuitry. Should this occur, wait 5 minutes before taking further measurements.*

Resistance is measured between the Ω and C terminals. Polarization is not important.

The meter uses a 100nA test current in its MΩ ranges and a 100uA test current in its kΩ ranges.

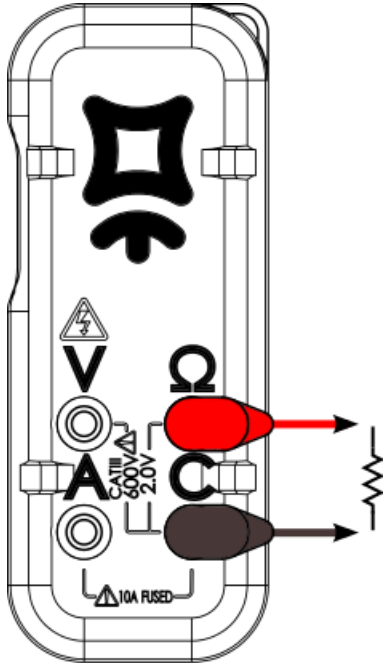


FIGURE 4 RESISTANCE MEASUREMENT

NOTE *Do not use the diode test functionality while connected to a live circuit. Doing so will result in incorrect readings and may engage the internal protection circuitry. Should this occur, wait 5 minutes before taking further measurements.*

To test diodes or other silicon junction devices, a test current is pushed through the device under test and the resulting voltage is measured.

Positive test current flows out of the Ω terminal and into the C terminal.

The test current is 100µA.

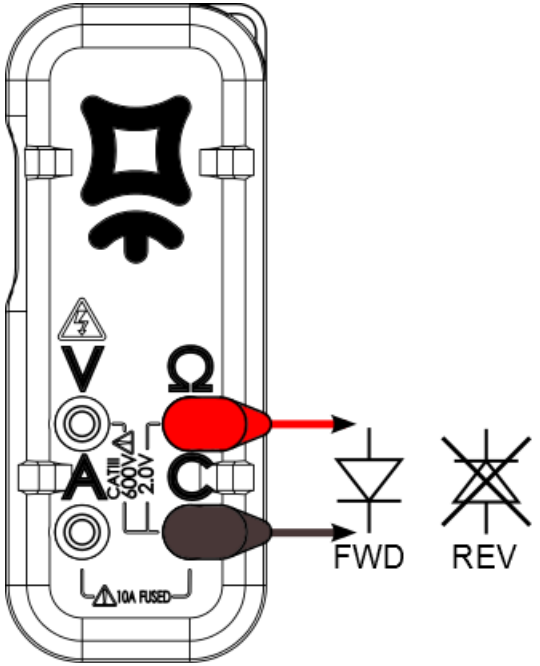


FIGURE 5 DIODE MEASUREMENT

USING A BNC ADAPTER

The 4 terminals are arranged with 0.75” spacing to allow for use of a standard BNC adapter. Measurements using the **A** or Ω terminals can be used with the **C** terminal as usual.

To use a BNC adapter with the “V” input, use the “A” terminal as the common input. The “A” and “C” terminals are internally connected with a low impedance (<=20mOhms).

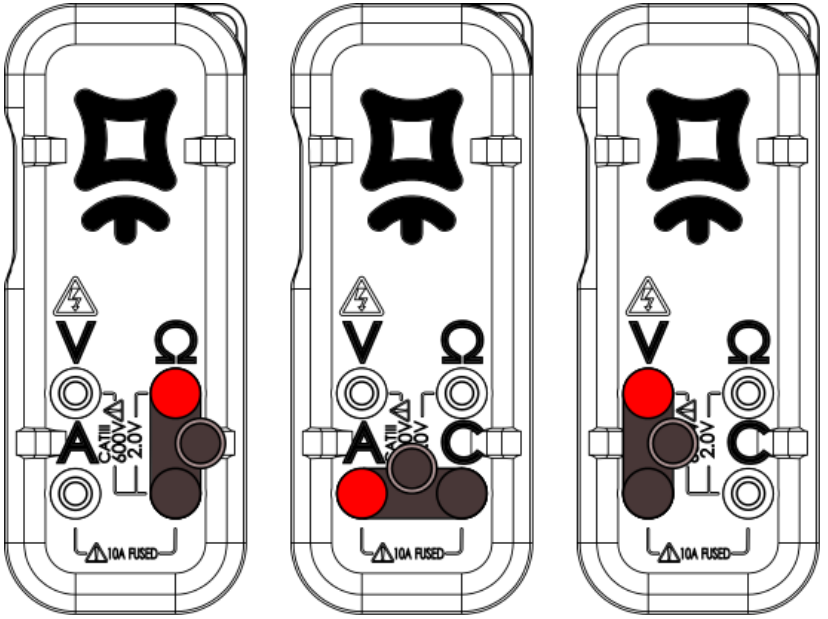


FIGURE 6 BNC ADAPTORS FOR **Ω**, **V**, **A** INPUTS

TWO CHANNEL MEASUREMENTS

Your Mooshimeter is capable of reading any two of its three channels simultaneously.

NOTE *Measurements using the internal current shunt will experience a degree of cross-talk due to the impedence of the Common lead. Other measurement types will also experience this cross-talk, but it should be negligible.*

MEASURING SMALL RESISTANCES / CALIBRATING A CURRENT SHUNT

The Mooshimeter can be used to measure small resistances in a live circuit. The meter simultaneously measures the current and the corresponding voltage with the precision voltage channel (**Ω**), and then finds the slope to calculate resistance.

This can be done with either the internal current shunt or an external current clamp. Using a current clamp allows the measurement to be done without breaking the circuit and allows for test currents above 10 Amps.

Wire the meter in as shown and enable the measurement mode. Apply a test current and run the analysis.

The analysis works best with several points along the curve. Therefore, the optimal test current has a large magnitude and a strong time-varying component below 1kHz. Often this test current can be the current already present within the system due to normal operation. For example, an AC system's steady state or a DC systems startup transient may provide sufficient data.

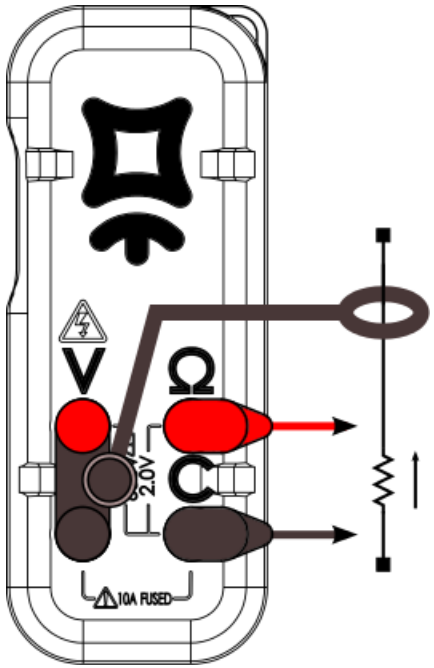
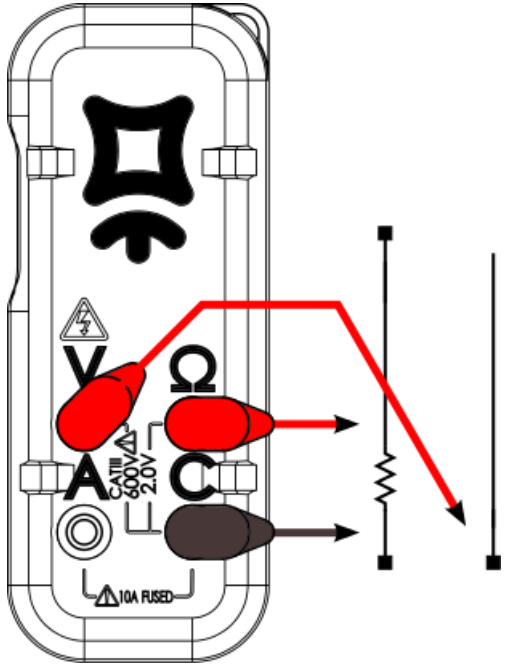


FIGURE 7 CURRENT CLAMP AND CURRENT SHUNT COMPARISON

POWER FACTOR

Power factor compares apparently power and actual power, and is a measure of how effectively a load uses available power. This measurement requires voltage and current measurements.

Current measurement can be done with either internal or external current shunt mode. Power Factor is a “unitless” measure, so the gain accuracy of the measurements does not affect the measurement accuracy. Therefore, the existing wiring can be used as an external current shunt without calibration.



MAINTANENCE

OPENING THE MOOSHIMETER

WARNING *To avoid electric shock, disconnect test leads from the meter before opening the meter.*

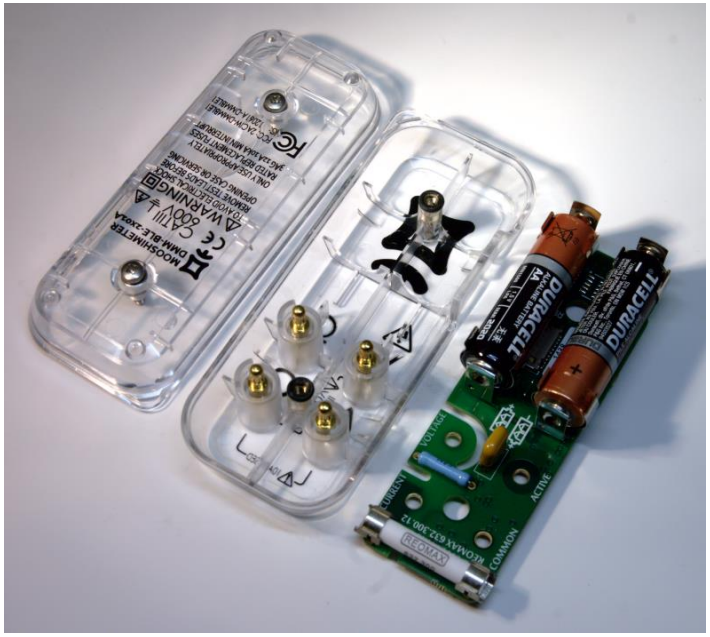
1. Disconnect all test leads.

2. Unscrew both retaining screws from the bottom of the case with a Phillips head screwdriver.

3. Separate the two halves.

4. Taking special care not to bend the circuit board, grasp the circuit board as shown near the connectors and pull it out of the top half of the enclosure.

5. Your Mooshimeter is now fully disassembled. The batteries, fuse and reset button are now accessible.



CLOSING THE MOOSHIMETER

WARNING *Risk of electrical shock. Do not operate the meter while partially disassembled.*

1. Place the PCB in the bottom enclosure half. Use the "J" shaped fin for alignment with the corresponding cut-out in the PCB.

2. Close the two halves together.

3. Replace both screws. Tighten firmly.

BATTERY REPLACEMENT

1. Open the Mooshimeter per directions above.
2. Remove old batteries.
3. Observe the battery polarity indication on the circuit board. Insert 2 new AA 1.5V batteries as shown on the circuit board.
4. If you have inserted the batteries with the correct polarity, the Mooshimeter's LED will blink slowly several times before turning off. If the light does not blink, check the battery polarity.
5. Close the Mooshimeter per directions above.

CLEANING

Gently wipe the assembled meter with a damp cloth.

Do not touch or apply cleaning agents to the circuit board.

Do not use any solvents or other cleaning agents while cleaning your Mooshimeter. The outer housing is a polycarbonate based material, and may be damaged by incompatible cleaners.

FUSE TEST

WARNING *Always perform a Fuse Test before using the internal current shunt measurement mode.*

1. Perform a resistance measurement with the C and Ω terminals connected
2. If the resistance measured is greater than 0.5Ω, replace the fuse*

* The resistance mode on the Mooshimeter is not accurate below 1Ω. The actual resistance of the fuse should be 20mΩ.

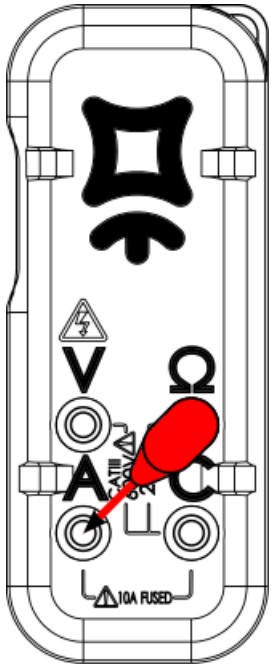


FIGURE 8 FUSE TEST

FUSE REPLACEMENT

WARNING Only use appropriately rated replacement fuse.

1. Open the Mooshimeter per directions above.
2. Gently remove existing fuse from holder.
3. Replace fuse only with appropriately rated replacement.
4. Recommended model:

   Reomax 632.300.12, available from Mooshim Engineering

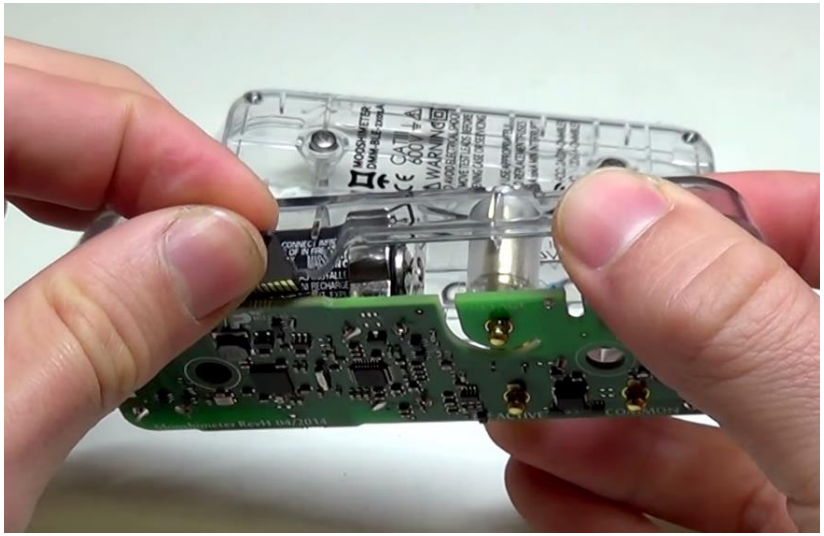
   Size 3AG 12A hold 600V 10kA minimum interrupt

5. Close the Mooshimeter per directions above.

REPLACING THE SD CARD

WARNING *To avoid electric shock, disconnect all leads from the meter.*

NOTE *Only use FAT32 formatted SD cards up to 32 gigabytes. Larger SD cards or cards formatted differently cannot be written to.*

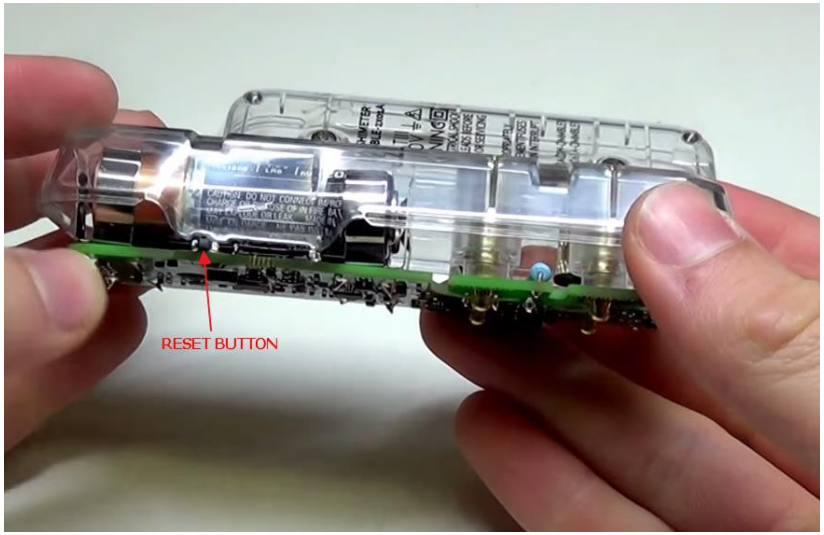


1. Open the Mooshimeter per the directions above.
2. Press the SD card further into the slot until you feel a click.
3. Release: The SD card will eject.
4. Remove old SD card and insert new SD card.
5. Push card in with finger until you feel a click.
6. Close the Mooshimeter per the directions above.

RESETTING THE MOOSHIMETER

WARNING *To avoid electric shock, disconnect all leads from the meter.*

1. Open the Mooshimeter per the directions above.
2. Press and Hold the button shown for 5 seconds
3. Close the Mooshimeter per the directions above



GENERAL SPECIFICATIONS

Accuracy is specified for 1 year after calibration within 18 to 28C. Accuracies listed are for single-channel measurements only. Multi-channel measurements may degrade accuracy. For extended specifications visit moosh.im/eter/specs

All AC ranges are RMS assuming a pure sinusoid (crest factor $\sqrt{2}$). Derate ranges linearly with increasing crest factor.

Maximum Voltage between any terminal and earth ground	600V
Surge Protection	6kV peak per IEC 61010-1 600V CATIII
Fuse for A input	12A Reomax 632.300.12
Temperature Coefficient	???????
Operating Altitude	Up to 2000m
Maximum Temperature Range	5C to 40C
Nominal Temperature Range	18C to 28C. Derate accuracy outside of this range
Input Power	3V 100mA from installed batteries
Battery	2x AA Alkaline, NEDA 15A IEC LR6
Battery Life	1 year typical standby 50 hours typical continuous active use
Size	? cm x ?? cm x ??? cm
Weight	??? g
Safety Compliance	EN61010-1:2010 Measurement Category III 600V EN61010-2-030
Pollution Degree	2
RF Communications	2.4 GHz ISM Band Bluetooth Low Energy
RF Communication Range	Free Space: Up to 50m
Electromagnetic compatibility	FCC Part 15.247 Subpart C ETSI EN 300-328 V1.7.1 EN 61326-1:2013 per EN 55011:2009 + A1: 2010 / Class A Radiated Emissions EN 61326-1:2013 / ETSI EN 301-489-1 V1.9.2 / EN 301-489-17 V2.2.1/ Immunity Testing

Voltage, Terminal V:

DC Range	AC Range	Resolution	Noise Floor	Accuracy (%+counts)
600 V	600 V	275 µV	9 mV	0.5 + 20
600 V	430 V	140 µV	5 mV	0.5 + 20
455 V	320 V	95 µV	3 mV	0.5 + 20
365 V	255 V	70 µV	3 mV	0.5 + 20
260 V	185 V	50 µV	2 mV	0.5 + 20
200 V	140 V	35 µV	1090 µV	0.5 + 20
135 V	95 V	25 µV	730 µV	0.5 + 20
60 V	45 V	20 µV	610 µV	0.5 + 20
40 V	30 V	10 µV	305 µV	0.5 + 20
30 V	22 V	6.4 µV	205 µV	0.5 + 20
25 V	18 V	4.8 µV	155 µV	0.5 + 20
18 V	12 V	3.2 µV	105 µV	0.5 + 20
14 V	10 V	2.4 µV	80 µV	0.5 + 20
9 V	6 V	1.6 µV	55 µV	0.5 + 20
1000 mV	700 mV	300 nV	10 µV	0.5 + 20
670 mV	475 mV	150 nV	5 µV	0.5 + 20
500 mV	350 mV	100 nV	4 µV	0.5 + 20
400 mV	275 mV	75 nV	3 µV	0.5 + 20
280 mV	200 mV	50 nV	2 µV	0.5 + 20
220 mV	150 mV	40 nV	2 µV	0.5 + 20
150 mV	100 mV	25 nV	1 µV	0.5 + 20

Current, Terminal A:

DC Range	AC Range	Resolution	Noise Floor	Accuracy (%+counts)
10 A	9 A	3.8 µA	120 µA	0.5 + 50
8.5 A	6 A	1.9 µA	60 µA	0.5 + 50
6 A	4.5 A	1.3 µA	40 µA	0.5 + 50
5 A	3.5 A	1 µA	30 µA	0.5 + 50
3.5 A	2.5 A	0.7 µA	20 µA	0.5 + 50
2.75 A	2 A	0.5 µA	15 µA	0.5 + 50
1.75 A	1.25 A	0.4 µA	10 µA	0.5 + 50

Resistance

Range	Resolution	Noise Floor	Accuracy (%+counts)
9 MΩ	1.5 Ω	50 Ω	1.0 + 50
8 MΩ	1 Ω	35 Ω	1.0 + 50
6 MΩ	750 mΩ	25 Ω	1.0 + 50
4 MΩ	500 mΩ	20 Ω	1.0 + 50
3 MΩ	375 mΩ	12 Ω	1.0 + 50
2 MΩ	250 mΩ	8 Ω	1.0 + 50
9.6 kΩ	1.5 mΩ	48 mΩ	1.0 + 50
8.2 kΩ	1 mΩ	32 mΩ	1.0 + 50
6.1 kΩ	750 µΩ	24 mΩ	1.0 + 50
4.1 kΩ	500 µΩ	16 mΩ	1.0 + 50
3 kΩ	375 µΩ	12 mΩ	1.0 + 50
2 kΩ	250 µΩ	8 mΩ	1.0 + 50

Voltage, Auxiliary Terminal:

DC Range	AC Range	Resolution	Noise Floor	Accuracy (%+count)
1000 mV	700 mV	300 nV	10 µV	0.5 + 20
680 mV	475 mV	150 nV	5 µV	0.5 + 20
510 mV	350 mV	100 nV	4 µV	0.5 + 20
400 mV	275 mV	75 nV	3 µV	0.5 + 20
290 mV	200 mV	50 nV	2 µV	0.5 + 20
220 mV	150 mV	40 nV	2 µV	0.5 + 20
150 mV	100 mV	25 nV	1 µV	0.5 + 20

Terminal	Surge Protection	Input Impedance
V	6kV	>10MΩ <200pF
Ω	800V	>100MΩ <200pF
		Burden Voltage
A	10kA 600V	<20µV/mA

Diode Voltage Drop

Range	Resolution	Noise Floor	Accuracy
2.2 V	300 nV	10 µV	1.0 + 50
1.2 V	150 nV	5 µV	1.0 + 50
825 mV	100 nV	3.5 µV	1.0 + 50
625 mV	75 nV	2.5 µV	1.0 + 50
400 mV	50 nV	1.75 µV	1.0 + 50
300 mV	40 nV	1.25 µV	1.0 + 50
200 mV	25 nV	800 nV	1.0 + 50

RADIO NOTICES

FCC Notice (for U.S. Customers):

This device complies with part 15 of the FCC Rules:

Operation is subject to the following conditions:

1. This device many not cause harmful interference, and
2. This device must accept any interference received, Including interference that may cause undesired operation

Changes and Modifications not expressly approved by Mooshim Engineering LLC can void your authority to operate this equipment under Federal Communications Commissions rules.

This device complies with Industry Canada license-exempt RSS standard(s)

Operation is subject to the following two conditions:

1. this device may not cause interference, and
2. this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. l'appareil ne doit pas produire de brouillage, et
2. l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.